

1 Payment will be made under:

| Pay Item | Pay Unit |
|---|-----------------|
| Foundation Excavation | Cubic Yard |
| Foundation Excavation for Bent No. ____ at Station ____ | Lump Sum |
| Foundation Excavation for End Bent No. ____ at Station ____ | Lump Sum |

2 **SECTION 411**

3 **DRILLED PIERS**

4 **411-1 DESCRIPTION**

5 Construct drilled piers consisting of cast-in-place reinforced concrete cylindrical sections in
6 excavated holes typically stabilized with casings or slurry. Provide permanent casings,
7 standard penetration tests, integrity testing and assistance with the shaft inspection device as
8 noted in the plans. Construct drilled piers with the required resistances and dimensions in
9 accordance with the contract and accepted submittals. Use a prequalified Drilled Pier
10 Contractor to construct drilled piers.

11 Define "excavation" and "hole" as a drilled pier excavation and "pier" as a drilled pier.
12 Define "rock" as a continuous intact natural material in which the penetration rate with a rock
13 auger is less than 2" per 5 minutes of drilling at full crowd force. This definition excludes
14 discontinuous loose natural materials such as boulders and man-made materials such as
15 concrete, steel, timber, etc. and is not for measurement and payment purposes. See
16 Article 411-7 for measurement and payment of drilled piers.

17 **411-2 MATERIALS**

18 Refer to Division 10.

| Item | Section |
|--|----------------|
| Grout, Nonshrink | 1003 |
| Portland Cement Concrete, Class Drilled Pier | 1000 |
| Reinforcing Steel | 1070 |

19 Provide Type 3 material certifications in accordance with Article 106-3 for permanent casings
20 and roller, chair, steel pipe and cap materials. Store steel materials on blocking at least 12"
21 above the ground and protect it at all times from damage; and when placing in the work make
22 sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials.
23 Load, transport, unload and store drilled pier materials so materials are kept clean and free of
24 damage.

25 **(A) Steel Casing**

26 Define "casing" as a temporary or permanent casing. Use smooth non-corrugated clean
27 watertight steel casings of ample strength to withstand handling and installation stresses
28 and pressures imposed by concrete, earth, backfill and fluids.

29 **(1) Temporary Casings**

30 Provide temporary casings with nominal wall thicknesses of at least 0.375" and
31 outside diameters equal to or larger than the design pier diameters for which casings
32 are used.

33 **(2) Permanent Casings**

34 Use permanent casings with yield strengths of at least 36 ksi and nominal wall
35 thicknesses that meet Table 411-1.

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| TABLE 411-1 MINIMUM PERMANENT CASING WALL THICKNESS | |
|--|------------------------|
| Casing Diameter | Nominal Wall Thickness |
| < 48" | 0.375" |
| 48" - 78" | 0.500" |
| > 78" | 0.625" |

- 1 Provide permanent casings with outside diameters equal to the design pier diameters
2 for which casings are used unless larger diameter permanent casings are approved.

3 (B) Slurry

- 4 Define "slurry" as bentonite or polymer slurry. Mix bentonite clay or synthetic polymer
5 with water to form bentonite or polymer slurry.

6 (1) Bentonite Slurry

- 7 Provide bentonite slurry that meets Table 411-2.

| TABLE 411-2 BENTONITE SLURRY REQUIREMENTS ^A | | |
|---|---|--------------------|
| Property | ANSI/API RP ^B 13B-1 | Requirement |
| Density ^C (Mud Weight) | Section 4 | 64.3 - 72.0 lb/cf |
| Viscosity | Section 6.2 Marsh Funnel | 28 - 50 sec/qt |
| Sand Content | Section 9 | ≤ 4 % ^D |
| | | ≤ 2 % ^E |
| pH | Section 11 Glass Electrode pH Meter ^F | 8 - 11 |

- 8 **A.** Slurry temperature of at least 40°F required
9 **B.** American National Standards Institute/American Petroleum Institute
10 Recommended Practice
11 **C.** Increase density requirements by 2 lb/cf in saltwater
12 **D.** In tanks before pumping slurry into excavations
13 **E.** In excavations immediately before placing concrete
14 **F.** pH paper is also acceptable for measuring pH

15 (2) Polymer Slurry

- 16 Use a polymer slurry product approved by the Department. Value engineering
17 proposals for other polymer slurry products will not be considered. A list of
18 approved polymer slurry products is available from the Department's website or the
19 Geotechnical Engineering Unit.

- 20 Provide polymer slurry that meets Table 411-3.

**TABLE 411-3
POLYMER SLURRY REQUIREMENTS^A**

| Property | ANSI/API RP^B 13B-1 | Requirement |
|--------------------------------------|---|------------------------|
| Density ^C (Mud Weight) | Section 4 | ≤ 64 lb/cf |
| Viscosity | Section 6.2 Marsh Funnel | 32 - 135 sec/qt |
| Sand Content | Section 9 | ≤ 0.5 % ^{D,E} |
| pH | Section 11 Glass Electrode pH Meter ^F | 8 - 11.5 |

A. Slurry temperature of at least 40°F required

B. American National Standards Institute/American Petroleum Institute Recommended Practice

C. Increase density requirements by 2 lb/cf in saltwater

D. In tanks before pumping slurry into excavations

E. In excavations immediately before placing concrete

F. pH paper is also acceptable for measuring pH

(C) Rollers and Chairs

Use rollers and chairs that are non-metallic and resistant to corrosion and degradation. Provide rollers with the necessary dimensions to maintain the minimum required concrete cover shown in the plans and center rebar cages within excavations. Use chairs of sufficient strength to support rebar cages in excavations and of the size necessary to raise cages off bottom of holes to maintain the minimum required distance shown in the plans.

(D) Steel Pipes and Caps

Use Schedule 40 black steel pipes for access tubes for crosshole sonic logging (CSL). Provide CSL tubes with an inside diameter of at least 1.5". Use CSL tubes with a round, regular inside diameter free of defects and obstructions, including any pipe joints, in order to permit free, unobstructed passage of probes for CSL testing. Provide watertight CSL tubes free of corrosion with clean internal and external faces to ensure a good bond between concrete and tubes. Fit CSL tubes with watertight plastic caps on the bottom and removable caps on top.

411-3 PRECONSTRUCTION METHODS

(A) Drilled Pier Construction Plan Submittal

Submit the proposed drilled pier construction plan for all drilled piers for acceptance. Provide 2 copies of this plan at least 30 days before starting drilled pier construction. Do not begin drilled pier construction until a construction plan is accepted. Provide detailed project specific information in the drilled pier construction plan that includes the following:

- (1) Overall description and sequence of drilled pier construction;
- (2) List and sizes of equipment including cranes, drill rigs, vibratory and downhole hammers, Kelly bars, augers, core barrels, casings (diameters, thicknesses and lengths), cleanout buckets, air lifts, pumps, slurry equipment, tremies, pump pipes and other equipment;
- (3) Procedures for casing installation and temporary casing removal including how telescoping temporary casings will be removed;

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- (4) If applicable, details of slurry testing and use including intended purpose, product information and additives, manufacturer's recommendations for use, name and contact information for slurry manufacturer's technical representative, mixing and handling procedures and how slurry level will be maintained above the highest piezometric head;
- (5) Methods for drilling and cleaning holes including how cores will be removed and drilling spoils and slurry will be handled and disposed of;
- (6) Details of CSL tubes, caps and joints including pipe size and how tubes will be attached to reinforcing steel;
- (7) Procedures for lifting and setting reinforcing steel including how rebar cages will be supported and centralized;
- (8) Procedures for placing concrete including how tremies and pump pipes will be controlled and contaminated concrete will be contained;
- (9) Concrete mix design that meets Section 1000;
- (10) Approved packaged grout or grout mix design that meets Section 1003;
- (11) CSL Consultant including Field and Project Engineer; and
- (12) Other information shown in the plans or requested by the Engineer.

If alternate construction procedures are proposed or necessary, a revised drilled pier construction plan submittal may be required. If the work deviates from the accepted submittal without prior approval, the Engineer may suspend drilled pier construction until a revised plan is accepted.

(B) Preconstruction Meeting

Before starting drilled pier construction, hold a preconstruction meeting to discuss the installation, monitoring and inspection of the drilled piers. Schedule this meeting after all drilled pier submittals have been accepted and the Drilled Pier Contractor has mobilized to the site. The Resident or Bridge Maintenance Engineer, Bridge Construction Engineer, Geotechnical Operations Engineer, Contractor and Drilled Pier Contractor Superintendent will attend this preconstruction meeting.

411-4 CONSTRUCTION METHODS

Do not excavate holes, install piles or allow equipment loads or vibrations within 20 ft of completed piers until 16 hours after Drilled Pier concrete reaches initial set.

When drilling from a barge, use a fixed template that maintains hole position and alignment during drilled pier construction. Do not use floating templates or templates attached to barges.

Check for correct drilled pier alignment and location before beginning drilling. Check plumbness of Kelly bars before beginning and frequently during drilling.

Construct drilled piers with the minimum required diameters shown in the plans except for piers constructed with permanent casings and slurry or permanent casings to rock. For these situations, the pier diameter may be 2" less than the design pier diameter shown in the plans.

Install drilled piers with tip elevations no higher than shown in the plans or approved by the Engineer. Provide piers with the minimum required tip resistance and, when noted in the plans, penetration into rock.

(A) Excavation

Excavate holes with equipment of the sizes required to construct drilled piers. Use equipment and methods accepted in the drilled pier construction plan or approved by the Engineer. Inform the Engineer of any deviations from the accepted plan.

Use drill rigs with sufficient capacity to drill through soil, rock, boulders, timbers, man-made objects and any other materials encountered and drill 20 ft deeper or 20% longer than the maximum drilled pier length shown in the plans, whichever is greater. Drilling below pier tip elevations shown in the plans may be required to attain sufficient resistance.

Do not use blasting to advance drilled pier excavations. Blasting for core removal is only permitted when approved by the Engineer. Contain and dispose of drilling spoils and waste concrete as directed and in accordance with Section 802. Drilling spoils consist of all materials and fluids removed from excavations.

Stabilize excavations with only casings or slurry and casings except, as approved by the Engineer, portions of excavations in rock. Use casings or slurry in rock if unstable material is anticipated or encountered. Stabilize excavations from beginning of drilling through concrete placement. If excavations become unstable, the Engineer may suspend drilling and require a revised drilled pier construction plan. If it becomes necessary to replace a casing during drilling, backfill the excavation, insert a larger casing around the casing to be replaced or stabilize the excavation with slurry before removing the casing.

When noted in the plans, do not dewater drilled pier excavations. Otherwise, if excavations are in rock, dewater excavations to the satisfaction of the Engineer.

(B) Casings

Provide temporary casings to stabilize holes and protect personnel entering excavations. Permanent casings may be required as noted in the plans. Install permanent casings with tip elevations no deeper than shown in the plans or approved by the Engineer. Additional drilled pier length and reinforcing steel may be required if permanent casings are installed below elevations noted in the plans.

Install casings in continuous sections. Overlap telescoping casings at least 24". Remove casings and portions of permanent casings above the ground line or top of piers, whichever is higher, after placing concrete. Do not cut off permanent casings until Drilled Pier concrete attains a compressive strength of at least 3,000 psi.

When using slurry construction without permanent casings, temporary casings at least 10 ft long are required at top of excavations. Maintain top of casings at least 12" above the ground line.

(C) Slurry Construction

Unless noted otherwise in the plans, slurry construction or polymer slurry is at the Contractor's option.

Use slurry and additives to stabilize holes in accordance with the manufacturer's recommendations. Provide a technical representative employed by the slurry manufacturer to assist and guide the Drilled Pier Contractor onsite during the construction of the first drilled pier. If problems are encountered during drilled pier construction, the Engineer may require the technical representative to return to the site.

Provide documentation that mixing water is suitable for slurry. Use slurry equipment that is sufficient for mixing, agitating, circulating and storing slurry. Thoroughly premix slurry with water in tanks before pumping into excavations. Allow bentonite slurry to hydrate at least 24 hours in tanks before use.

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Pump slurry into excavations before encountering water. Maintain slurry level at least 5 ft or one pier diameter, whichever is greater, above the highest piezometric head along the drilled pier length. The highest piezometric head is anticipated to be the static water or groundwater elevation. However, the Drilled Pier Contractor is responsible for determining the highest piezometric head for each pier.

Maintain the required slurry properties at all times except for sand content. Desand or replace slurry as needed to meet the required sand content in tanks before pumping slurry into excavations and in excavations immediately before placing concrete.

(1) Time

Agitate bentonite slurry in holes at least every 4 hours. If this 4-hour time limit is exceeded, the Engineer may require holes to be overreamed at least 1" and no more than 3" below casings. Overream holes with grooving tools, overreaming buckets or other approved methods.

Construct drilled piers so the maximum time slurry is in contact with uncased portions of holes from drilling through concrete placement does not exceed 36 hours. If this 36 hour time limit is exceeded, the Engineer may require the hole diameter to be enlarged at least 6". If the enlarged hole diameter is greater than the permanent casing diameter, replace casing with a larger permanent casing with an outside diameter equal to the diameter of the enlarged hole.

(2) Slurry Testing

Define a "sample set" as slurry samples collected from mid-height and within 2 ft of the bottom of slurry tanks or holes. Take a sample set from slurry tanks to test slurry before beginning drilling. Do not pump slurry into excavations until both slurry samples from tanks meet the required slurry properties. Take sample sets from excavations to test slurry at least every 4 hours and immediately before placing concrete. Do not place Drilled Pier concrete until both slurry samples from an excavation meet the required slurry properties. If any slurry test results do not meet the requirements, the Engineer may suspend drilling until both samples from a sample set meet the required slurry properties.

Sign, date and submit slurry test reports upon completion of each pier. The Department reserves the right to perform comparison slurry tests at any time.

(3) Disposal

Comply with all Federal, State and local regulations, as well as the project permits and commitments, when disposing of slurry and drilling spoils mixed with slurry. Contain slurry and drilling spoils and keep out of water at all times.

(D) Cleaning and Inspection

Provide clean holes with level bottoms so elevations within bottom of holes do not vary by more than 12". Remove soft and loose material from bottom of holes using methods accepted in the drilled pier construction plan or approved by the Engineer. When bottom of holes are not hand cleaned, remove sediment from holes with cleanout buckets, air lifts or pumps.

After cleaning is complete, provide all equipment, personnel and assistance required for the Engineer to visually inspect holes from above or by entering excavations. Remove all cleaning and drilling equipment from holes during inspections and do not interfere with inspections.

(1) Tip Resistance

If the Engineer determines that the material below an excavation does not provide the minimum required tip resistance, increase the drilled pier length and lengthen reinforcing steel as directed. One of the following methods may be required to check the conditions and continuity of material below excavations.

(a) Test Hole

If excavations are in rock, drill a 1.5" diameter test hole at least 6 ft below bottom of holes for the Engineer to determine the continuity of rock below holes.

(b) Standard Penetration Test

Standard penetration tests (SPT) may be required as noted in the plans. When required, drive a split-barrel sampler 18" below bottom of holes or to refusal in accordance with ASTM D1586. Perform SPT in holes at least 12" away from casing walls and support drill rods so rods remain vertical and straight. Report the number of blows applied in each 6" increment and provide recovered samples to the Engineer. The Engineer will determine the standard penetration resistance required.

(2) Bottom Cleanliness

Holes are clean if at least 50% of bottom of holes has less than 0.5" of sediment and no portions of bottom of holes have more than 1.5" of sediment. If bottom of holes does not meet this cleanliness criteria, remove sediment from holes until the Engineer determines holes are clean. One or more of the following methods may be required to inspect the bottom cleanliness of holes.

(a) Steel Probe

If drilled pier excavations are not dewatered or as directed, provide a #10 rebar steel probe that is 24" long with a flat tip on one end and a non-stretch cable connected to the other end. Provide a cable long enough to lower the steel probe to the bottom of holes for the Engineer to determine the amount of sediment in holes.

(b) Shaft Inspection Device

The Engineer may use the shaft inspection device (SID) as noted in the plans. The Engineer provides the SID and personnel to operate it. Notify the Engineer at least 2 days before finishing holes that will be inspected with the SID.

Assist the Engineer in handling the SID and associated equipment and supporting the SID during inspections. Provide working areas large enough for the SID, associated equipment and SID personnel within reach of the SID cables and clear view of holes being inspected. If necessary, provide a secure location to store the SID and associated equipment onsite overnight.

Approximately one hour is required to inspect a hole with the SID after the SID and associated equipment are set up. The Engineer will use the SID to measure the amount of sediment at 5 locations around the bottom of holes.

(E) Reinforcing Steel and Concrete

Assemble rebar cages consisting of bar and spiral reinforcing steel shown in the plans. Securely cross tie reinforcing steel at each intersection with double wire. Attach a chair under each reinforcing bar and rollers near the top and bottom of rebar cages and every 10 ft along cages in between. The number of rollers required at each location along rebar cages is one roller per foot of design pier diameter with at least 4 rollers per location.

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Space rollers equally around rebar cages at each location. Attach rollers so rollers are supported across 2 adjacent reinforcing bars and will freely rotate when rebar cages are lowered into excavations.

If CSL tubes are required, securely attach CSL tubes to spiral reinforcing steel on the inside of rebar cages with at least 3" clearance to reinforcing bars. Extend CSL tubes from 6" above pier tip elevations to at least 2 ft above the ground line or top of permanent casings, whichever is greater. The number of CSL tubes required for each drilled pier is one tube per foot of design pier diameter with at least 4 tubes per pier. Space CSL tubes equally around rebar cages so distances between tubes measured around spiral reinforcing steel are uniform. Install CSL tubes as straight and parallel to each other as possible. Fit caps on top and bottom of CSL tubes.

After the Engineer determines that the material below excavations provides the minimum required tip resistance and holes are clean, place rebar cages and then concrete in excavations. Do not rack or distort rebar cages and CSL tubes when lifting and handling cages. Set rebar cages directly on bottom of holes or, as approved by the Engineer, hang cages from permanent casings. When hanging rebar cages, leave devices supporting cages in place until Drilled Pier concrete attains a compressive strength of at least 3,000 psi.

Do not delay placing cages or concrete unless excavations are cased to rock or otherwise approved. If delays occur, the Engineer may require removal of rebar cages to reinspect bottom cleanliness of holes. If bottom of holes does not meet the cleanliness criteria in Subarticle 411-4(D)(2), remove sediment from holes until the Engineer determines holes are clean before resetting rebar cages.

After placing rebar cages with CSL tubes, remove top caps, fill tubes with clean water and reinstall caps before placing concrete. Check for correct cage position before placing concrete and keep rebar cages plumb during concrete placement. Maintain cage position so rebar cages do not move vertically more than 6" and columns or footings have the minimum required concrete cover shown in the plans.

Remove all temporary casings during concrete placement. Do not twist, move or otherwise disturb temporary casings until the concrete depth inside casings is at least 10 ft or half the head, whichever is greater, above the bottom of casing being disturbed. Define "head" as the difference between the highest piezometric head along the drilled pier length and the static water elevation inside the excavation.

When removing temporary casings, maintain the required concrete depth above the bottom of casing being removed except when the concrete level is at or above top of piers. Sustain sufficient concrete depths to overcome pressures imposed by earth, backfill and fluids. As temporary casings are withdrawn, ensure fluids trapped behind casings is displaced upward and discharged out of excavations without contaminating or displacing concrete.

Pour concrete in excavations to form uniform jointless monolithic drilled piers. Do not trap soil, air, fluids or other contaminants in concrete. Remove contaminated concrete from top of piers at time of concrete placement.

Inform the Engineer of the volume of concrete placed for each pier. For piers constructed with slurry or as directed, record a graphical plot of depth versus theoretical and actual concrete volumes.

Dry or wet placement of concrete is at the Contractor's option for piers constructed with only casings if the water inflow rate into excavations is less than 6" per half hour after removing any pumps from holes. Wet placement of concrete is required for all other drilled pier construction.

(1) Dry Placement

If holes are filling with water for dry placement of concrete, dewater excavations as much as possible before placing concrete. For drilled piers less than 80 ft long, pour concrete down the center of excavations so concrete does not hit reinforcing steel or excavation sidewalls. For piers longer than 80 ft, place concrete with a tremie or pump pipe down the center of excavations so length of free fall is less than 80 ft.

(2) Wet Placement

For wet placement of concrete, maintain static water or slurry levels in holes before placing concrete. Place concrete through steel tremies or pump pipes. Use tremies with watertight joints and a diameter of at least 10". Pump concrete in accordance with Article 420-5. Use approved devices to prevent contaminating concrete when tremies or pump pipes are initially placed in excavations. Extend tremies or pump pipes into concrete at least 5 ft at all times except when the concrete is initially placed.

When the concrete level reaches the static water elevation inside the excavation, dry placement of concrete is permitted. Before changing to dry placement, pump water or slurry out of holes and remove contaminated concrete from the exposed concrete surface.

411-5 INTEGRITY TESTING

Define "integrity testing" as crosshole sonic logging (CSL) and pile integrity testing (PIT). Integrity testing may be required as noted in the plans or by the Engineer. The Engineer will determine how many and which drilled piers require integrity testing. Do not test piers until Drilled Pier concrete cures for at least 7 days and attains a compressive strength of at least 3,000 psi.

(A) Crosshole Sonic Logging

If CSL testing is required, use a prequalified CSL Consultant to perform CSL testing and provide CSL reports. Use a CSL Operator approved as a Field Engineer (key person) for the CSL Consultant. Provide CSL reports sealed by an engineer approved as a Project Engineer (key person) for the same CSL Consultant.

(1) CSL Testing

Perform CSL testing in accordance with ASTM D6760. If probes for CSL testing will not pass through to the bottom of CSL tubes, the Engineer may require coring to replace inaccessible tubes. Do not begin coring until core hole size and locations are approved. Core at least 1.5" diameter holes the full length of piers. Upon completion of coring, fill holes with clean water and cover to keep out debris. Perform CSL testing in core holes instead of inaccessible tubes.

For piers with 4 or 5 CSL tubes, test all tube pairs. For piers with 6 or more CSL tubes, test all adjacent tube pairs around spiral reinforcing steel and at least 50% of remaining tube pairs selected by the Engineer. Record CSL data at depth intervals of 2.5" or less from the bottom of CSL tubes to top of piers.

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(2) CSL Reports

Submit 2 copies of each CSL report within 7 days of completing CSL testing. Include the following in CSL reports:

(a) Title Sheet

- (i) Department's TIP number and WBS element number
- (ii) Project description
- (iii) County
- (iv) Bridge station number
- (v) Pier location
- (vi) Personnel
- (vii) Report date

(b) Introduction

(c) Site and Subsurface Conditions (including water table elevation)

(d) Pier Details

- (i) Pier and casing diameters, lengths and elevations
- (ii) Drilled Pier concrete compressive strength
- (iii) Installation methods including use of casings, slurry, pumps, tremies, dry or wet placement of concrete, etc.

(e) CSL Results

- (i) Logs with plots of signal arrival times and energy vs. depth for all tube pairs tested

(f) Summary/Conclusions

- (i) Table of velocity reductions with corresponding locations (tube pair and depth) for all tube pairs tested
- (ii) List of suspected anomalies with corresponding locations (tube pair(s) and depth range)

(g) Attachments

- (i) Boring log(s)
- (ii) Field inspection forms and concrete curves (from Engineer)
- (iii) CSL tube locations, elevations, lengths and identifications
- (iv) CSL hardware model and software version information
- (v) PDF copy of all CSL data

(B) Pile Integrity Testing

If required, the Engineer will perform PIT. Provide access to and prepare top of piers for PIT as directed. See ASTM D5882 for PIT details.

(C) Further Investigation

Define "further investigation" as any additional testing, excavation or coring following initial integrity testing. Based on concrete placement and initial integrity testing results, the Engineer will determine if drilled piers are questionable and require further investigation within 7 days of receiving CSL reports or completing PIT. For initial CSL testing, the Engineer will typically determine whether further investigation is required based on Table 411-4.

| TABLE 411-4 DRILLED PIER FURTHER INVESTIGATION CRITERIA (For Initial CSL Testing) | |
|--|--|
| Velocity Reductions | Further Investigation Required? |
| < 20% | No |
| 20 - 30% | As Determined by the Engineer |
| > 30% | Yes |

1 If further investigation is necessary, the Engineer will typically require one or more of the
 2 following methods to investigate questionable piers.

3 (1) CSL Testing

4 If required, use CSL testing as described above to retest questionable piers and as
 5 directed, perform testing with probes vertically offset in CSL tubes. CSL offset data
 6 will typically be required for all locations (tube pair and depth) with velocity
 7 reductions greater than 30% and at other locations as directed. Record offset data at
 8 depths, intervals and angles needed to completely delineate anomalies.

9 Provide CSL reports that meet Subarticle 411-5(A)(2). When CSL offset data is
 10 required, perform tomographic analysis and provide 3 dimensional color coded
 11 tomographic images of piers showing locations and sizes of anomalies.

12 (2) Excavation

13 If required, excavate around questionable piers and remove permanent casing as
 14 needed to expose Drilled Pier concrete. Do not damage piers when excavating or
 15 removing casings. The Engineer will determine the portions of piers to expose.

16 (3) Coring

17 If required, core questionable piers and provide PQ size cores that meet
 18 ASTM D2113. The Engineer will determine the number, location and depth of core
 19 holes required. Handle, log and store concrete cores in accordance with
 20 ASTM D5079. Provide cores to the Engineer for evaluation and testing. Sign, date
 21 and submit core logs upon completion of each core hole.

22 **(D) Defective Piers**

23 For questionable piers that are exposed or cored, the Engineer will determine if piers are
 24 defective based on the results of excavation or coring. For questionable piers that are not
 25 exposed or cored, the Engineer will determine if piers are defective based on the results
 26 of integrity testing. Questionable piers with only CSL testing will be considered
 27 defective if any velocity reductions between any tube pairs are greater than 30%.

28 **411-6 DRILLED PIER ACCEPTANCE**

29 Drilled pier acceptance is based in part on the following criteria:

30 **(A)** Temporary casings and drilling tools are removed from the drilled pier excavation or the
 31 Engineer determines that a temporary casing may remain in the excavation.

32 **(B)** Drilled Pier concrete is properly placed and does not have any evidence of segregation,
 33 intrusions, contamination, structural damage or inadequate consolidation
 34 (honeycombing).

35 **(C)** Center of pier is within 3" of plan location and 2% of plumb. Top of pier is within
 36 1" above and 3" below the elevation shown in the plans or approved by the Engineer.

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(D) Rebar cage is properly placed and top and center of cage is within tolerances for center of pier. Tip of permanent casing does not extend below the elevation noted in the plans or approved by the Engineer.

(E) Drilled pier is not defective or the Engineer determines the defective pier is satisfactory. A pier will be considered defective based on Subarticle 411-5(D).

Do not grout CSL tubes or core holes, backfill around a pier or perform any work on a drilled pier until the Engineer accepts the pier. If the drilled pier is accepted, dewater and grout CSL tubes and core holes, and backfill around the pier with approved material to finished grade. If the Engineer determines a pier is unacceptable, remediation is required. Remediation may include, but is not limited to grouting, removing part or all of unacceptable piers, modifying pier designs or providing replacement or additional piers or piles. Submit working drawings and design calculations for acceptance in accordance with Article 105-2. Ensure remediation submittals are designed, detailed and sealed by an engineer licensed by the State of North Carolina. Do not begin remediation work until remediation plans are approved. When repairing unacceptable piers, perform post repair testing to gauge success of the repair. No extension of completion date or time will be allowed for remediation of unacceptable drilled piers or post repair testing.

411-7 MEASUREMENT AND PAYMENT

____ Dia. Drilled Piers in Soil, ____ Dia. Drilled Piers Not in Soil and ____ Dia. Drill Piers will be measured and paid in linear feet. Acceptable drilled piers will be measured as the difference between the specified top of pier and pier tip elevations or revised elevations approved by the Engineer.

For bents with a not in soil pay item shown in the plans, drilled piers will be paid as ____ Dia. Drilled Piers in Soil and ____ Dia. Drilled Piers Not in Soil. Define "not in soil" as material with a rock auger penetration rate of less than 2" per 5 minutes of drilling at full crowd force. When not in soil is encountered, seams, voids and weathered rock less than 3 ft thick with a rock auger penetration rate of greater than 2" per 5 minutes of drilling at full crowd force will be paid at the contract unit price for ____ Dia. Drilled Piers Not in Soil. Seams, voids and weathered rock greater than 3 ft thick will be paid at the contract unit price for ____ Dia. Drilled Piers in Soil where not in soil is no longer encountered. For bents with a not in soil pay item shown in the plans, drilled piers through air or water will be paid at the contract unit price for ____ Dia. Drilled Piers in Soil.

For bents without a not in soil pay item shown in the plans, drilled piers will be paid as ____ Dia. Drill Piers. The contract unit price for ____ Dia. Drilled Piers will be full compensation for drilling through any materials encountered.

The contract unit prices for ____ Dia. Drilled Piers in Soil, ____ Dia. Drilled Piers Not in Soil and ____ Dia. Drill Piers will also be full compensation for spoils and slurry containment and disposal, slurry construction including a slurry manufacturer representative and overreaming and enlarging piers and any concrete removal, miscellaneous grading and excavation. No additional payment will be made for excess Drilled Pier concrete due to caving or sloughing holes or telescoping casings.

Reinforcing steel will be measured and paid in accordance with Article 425-6.

Permanent Steel Casing for ____ Dia. Drilled Pier will be measured and paid in linear feet. Permanent casings will only be paid for when required by the Engineer or shown in the plans. Permanent casings will be measured as the difference between the ground line or specified top of pier elevation, whichever is higher, and the specified permanent casing tip elevation or revised elevation approved by the Engineer. If a permanent casing cannot be installed to the tip elevation shown in the plans, up to 3 ft of casing cut-off will be paid at the contract unit price for Permanent Steel Casing for ____ Dia. Drilled Pier.

SID Inspections will be measured and paid in units of each. *SID Inspections* will be measured as one per pier. The contract unit price for *SID Inspections* will be full compensation for inspecting holes with the SID the first time. No additional payment will be made for subsequent inspections of the same hole.

The Contractor is responsible for any damage to the SID equipment due to the Contractor's fault or negligence. Replace any damaged equipment at no additional cost to the Department.

SPT Testing will be measured and paid in units of each. *SPT Testing* will be measured as the number of standard penetration tests performed.

CSL Testing will be measured and paid in units of each. *CSL Testing* will be measured as one per pier. The contract unit price for *CSL Testing* will be full compensation for performing initial CSL testing and providing CSL reports. Subsequent CSL testing of and CSL reports for the same pier will be considered further investigation. No separate payment will be made for CSL tubes. CSL tubes including coring for inaccessible tubes and grouting will be incidental to the contract unit prices for drilled piers.

No payment will be made for stuck temporary casings that cannot be removed from drilled pier excavations or additional drilled pier length and reinforcing steel required due to temporary casings that remain in excavations. No payment will be made for PIT. No payment will be made for further investigation of defective piers. Further investigation of piers that are not defective will be paid as extra work in accordance with Article 104-7. No payment will be made for remediation of unacceptable drilled piers or post repair testing.

Payment will be made under:

| Pay Item | Pay Unit |
|--|-----------------|
| ____ Dia. Drilled Piers in Soil | Linear Foot |
| ____ Dia. Drilled Piers Not in Soil | Linear Foot |
| ____ Dia. Drilled Piers | Linear Foot |
| Permanent Steel Casing for ____ Dia. Drilled Piers | Linear Foot |
| SID Inspections | Each |
| SPT Testing | Each |
| CSL Testing | Each |

SECTION 412

UNCLASSIFIED STRUCTURE EXCAVATION

412-1 DESCRIPTION

Excavate any material not classified as foundation excavation, box culvert excavation or channel excavation whose removal is required for the construction of bridges, retaining walls of reinforced concrete or reinforced masonry, arch culverts and box culverts without floor slabs, and which is classified as unclassified structure excavation in the plans, in accordance with the contract or as directed. Excavate, blast, brace, shore, provide sheeting and cribbing, backfill, haul and dispose of materials.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures, in rivers, streams or impoundment or so near to such waters that they are carried into any river, stream or impoundment by stream flow or surface runoff.

Dispose of all timber, stumps and debris in accordance with Article 200-6.

412-2 PRESERVATION OF CHANNEL

Unless otherwise required by the contract, do not excavate in stream channels. Do not disturb the natural stream bed adjacent to the structure without permission.

Do not place material in a stream without approval. Remove materials placed within the stream area and leave the stream in its original condition, unless otherwise permitted.